**Traffic Signal Optimization Using Real-Time Vehicle Density**

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**Abstract:**

Urban traffic congestion and delayed emergency response are critical challenges in modern cities. TOURVD, a real-time AI-powered system, integrates YOLOv8 for vehicle detection, EfficientNet for accident recognition, and dynamic signal optimization. With emergency vehicle prioritization and a user-friendly dashboard, the system enables intelligent traffic management. Testing shows improved throughput, faster response, and significant potential for smart city deployment.

**Keywords:**

YOLOv8, EfficientNet, Real-time Traffic Detection, Accident Recognition, Smart Traffic Signal Control.

**I. INTRODUCTION**

The exponential rise in urbanization and motorization has led to complex challenges in traffic management, especially in growing metropolitan cities. As populations surge and infrastructure lags behind, traffic congestion has become a daily struggle for commuters and a significant bottleneck for urban productivity. Traditional traffic control mechanisms based on static signal timing or rudimentary sensors are incapable of responding dynamically to traffic fluctuations.

These systems function with fixed green-red cycles regardless of actual vehicle presence, resulting in underutilized road capacity on some lanes while others are congested. In a modern city, traffic patterns are continuously changing, influenced by work schedules, public events, accidents, road closures, and weather conditions. Fixed-time signal systems lack the contextual intelligence to accommodate these dynamic factors, often worsening traffic delays instead of easing them. Moreover, traffic congestion has wider implications beyond delayed travel. It directly impacts fuel consumption, environmental emissions, road safety, and public health.

Prolonged idling in queues increases greenhouse gas emissions, contributing to climate change and air pollution. The inefficiency of static systems becomes more evident during peak hours or when emergency situations arise. Emergency vehicles such as ambulances or fire trucks struggle to move swiftly due to blocked intersections and lack of priority in the signal logic. In addition, traffic administrators face challenges in detecting accidents quickly, as most surveillance systems rely on manual monitoring. This delay in incident detection can lead to secondary collisions and extended road closures.

Recognizing these limitations, there is a growing demand for intelligent traffic control systems that leverage real-time data and artificial intelligence to optimize signal behavior. TOURVD (Traffic Optimization and Unusual Road Vehicle Detection) is designed as a scalable and intelligent solution that employs deep learning, computer vision, and real-time analytics to automate traffic signal management. The system monitors traffic via video feeds, detects vehicles using YOLOv8, classifies accidents with EfficientNet, and estimates lane-wise vehicle density.